CHAPTER 6

Making Streamflow Measurements

You may have seen a scientist standing in a stream, holding a measuring rod and taking notes. Or you may have driven past a small gage house near a river or adjacent to a bridge. These are ways that scientists measure how much water is flowing in rivers.

It is important to understand streamflow for a number of reasons. As mentioned in previous chapters, scientists use streamflow to help estimate recharge and discharge to the ground-water system. Changes in streamflow often are related to climatic variations, such as seasons and droughts. Streamflow can be used to estimate precipitation volumes in some basins. And streamflow measurements help agencies such as the National Weather Service understand climate patterns and assess the risk of floods. These are just some of the many reasons why measuring streamflow is important.

USGS hydrologist, Tim Rowe, measuring streamflow.

The purpose of making a streamflow measurement is to assess the discharge of a stream. Discharge is the amount (volume) of water moving past some point over a given period of time. Streamflow is typically measured in cubic feet per second (cfs). For example, if a stream has a discharge measurement of 15 cfs, this means that 15 cubic feet (about 112 gallons) of water is flowing past that section of the stream channel each second.

To measure streamflow, one first needs to measure the cross section of the stream channel and the velocity (speed) of the water flow. Each of these will be discussed separately and then, how they relate to each other.

The cross section of the stream channel is the width of the stream multiplied by the depth of the stream at a particular measuring location. Obviously, stream widths and depths vary greatly along any stream channel. This is why scientists try to measure streamflow at the same location each time. The stream channel is not a rectangle, and the bottom varies as one crosses a stream. Because of this, it is important to measure the depth of water at many points across a stream in order to get an accurate profile of the channel bottom.

The stream velocity is the measure of how fast the water is moving past a point. One can get an idea of how fast a stream is flowing by throwing a stick into the water and watching how quickly it is carried downstream. However, because the stream flows quickest at the middle of the stream on the stream surface, this simple method might be misleading. Friction along the base of the stream, where water is flowing past rocks and sediment, makes the water move slower in these areas. Therefore, to get an accurate picture of how fast the stream flows, many measurements of velocity at many different points across a stream and at many different depths need to be made in order to get average velocity for the stream.

The cross section and stream velocity are tied closely to one another. In most cases, the same volume of water moving through a stream in one location is about the same volume of water moving through the same stream at a point 100 yards down stream. Yet, the water may be moving faster in one location than the other. Maybe one location has rapids, where the water seems to be full of energy. This is a factor of the cross section. If the stream narrows through a canyon, then that same volume of water has to move much quicker to get through. Likewise, if the stream banks get wider, then the streamflow slows down accordingly. The velocity of the stream is controlled by the surrounding channel conditions.

Scientists calculate streamflow by making a number of measurements of depth and velocity across the stream. This is done using a flowmeter, which consists of a rod that can measure water depth and an attached set of cups that spin in the water as the flow passes by. The spinning cups will click with each

USGS scientist measuring streamflow. Yellow tape is used to determine the location of the streamflow measurement at that cross section.

rotation, so that the scientist can count the number of clicks over a period of time (for example, one minute) and calculate the velocity of the stream at that depth and location along the cross section.

Because it is important to get a good profile of the stream due to the changes in the channel bottom and variations in velocity, scientists make many measurements along each cross section. Typically, the stream is divided into sections so that each section has no more than about 5 percent of the total streamflow. This means that the scientist needs to measure the depth and velocity at about 20 to 25 locations across the stream. Also, because the stream velocity changes with depth, measurements of velocity are made at depths of 60 percent (shallow streams) or 20 percent and 80 percent (deep streams) of the total depth for each section. Calculations have shown that averaging the velocities at these depths gives a good estimate of the average velocity for that particular section.

By calculating the average velocity and depth of water at each measuring point along a stream cross section, a discharge can be calculated for each section. Then, by adding all the discharges together, a total discharge for a stream at a location can be calculated. USGS scientists typically visit a stream about every 6 weeks to make these measurements.

Because streamflow can vary greatly in between visits to a site, information about stream stage (the height of the water in the stream) is collected. This is done by measuring the level directly in the stream, or in many cases, through a stilling well. A stilling well is a large shaft that goes into the ground near a stream and has a pipe from the shaft that is open in the stream. Water levels in the stilling well are the same as the levels in the stream, so changes in stream stage can be measured in the stilling well. A small gage house often is built over the stilling well. In the gage house are instruments that record the changes in the stage. Scientists either collect the recorded information when visiting the site every 6 weeks or it is transmitted via satellite to the science offices and presented on the internet.

If enough measurements of stream discharge and stream stage are made over time, a relation between the two values can be determined. This is very useful because scientists can then use measurements of stream stage to estimate discharge. Therefore, the stream discharge in between the times a site is visited can be determined using the continuous stage measurements.

Obviously, there is much more to making and using streamflow measurements, but this gives a general overview of how and why the measurements are collected.

USGS gage house at Upper Truckee River.
Photograph by Emil Stockton, USGS.

Crest-stage gage at Lamoille Creek.